PATENT ABSTRACTS OF JAPAN

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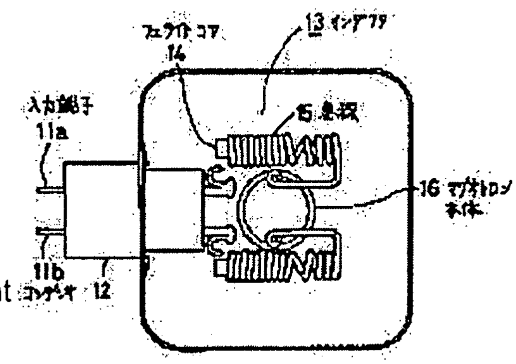
(54) MAGNETRON FOR MICROWAVE OVEN

(57)Abstract:
PURPOSE: To provide a magnetron for a microwave oven, which can suppress noises in a high frequency band from 500 to 1000MHz.
CONSTITUTION: A magnetron is structured so that a filter having a core-form inductor 13 is connected with input terminals 11a, 11b to which a supply voltage is supplied. The number of turns of that winding 15 portion of inductor 13 which is wound on the periphery of the core 14 part is made 2-4 smaller than in the arrangement in which the winding is formed with a length corresponding to the half wavelength of the frequency of the noise to be suppressed.



LEGAL STATUS

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the magnetron for microwave ovens used for a microwave oven etc.
[0002]
[Description of the Prior Art] Conventionally, a magnetron is used, being included in the microwave oven which performs cooking, defrosting, etc. of food. By the way, the conditions over noises, such as a microwave oven, are severe, and control of a noise is becoming important. Various approaches are proposed in order to control the noise of such a microwave oven. One of them is the approach of reducing the noise which the magnetron itself generates.
[0003] Here, how to reduce the noise which a magnetron generates is explained with reference to drawing 5 . Drawing 5 is drawing showing the input part of the magnetron used for a microwave oven, and 51a and 51b are input terminals, and are connected to a power source (not shown). The capacitor 52 and the inductor 53 are connected to input terminals 51a and 51b. In addition, the core form inductor by which the inductor 53 coiled the coil 55 around the periphery of a ferrite core 54 is used. And an inductor 53 is connected to the cathode (not shown) of the magnetron body 56. In addition, the capacitor 52 and the inductor 53 formed the low-pass frequency passage form filter, and have controlled the noise which leaks outside through input terminals 51a and 51b.
[0004] Drawing 6 is the circuit diagram of a configuration of having described above, and the explanation which gives the same sign to the part corresponding to drawing 5 , and overlaps is omitted. As shown in drawing 6 , the capacitor 52 is connected with input terminals 51a and 51b between touch-down between input terminal 51a and 51b, respectively. Moreover, it connects with each input terminals 51a and 51b, and the inductor 53 is connected to Cathode F.
[0005] In addition, the core form inductor by which the inductor 53 coiled the coil 55 around the periphery of the ferrite core 54 with high relative permeability as drawing 7 showed is used. In this case, formal copper wire etc. is used for a coil 55. Moreover, an inductor 53 consists of the core section A which has a ferrite core 54 in the interior of a coil 55, and the air core section B without a ferrite core 54. And the air core section B side is connected to the cathode of a magnetron body.
[0006] The magnetron of a configuration of having described above is oscillated by 2450MHz, and almost all the energy is outputted outside as microwave power through the magnetron output section. However, the part leaks to an input terminal side. If a part of energy leaks to an input side, microwave energy will form a standing wave on a coil 55, and will produce the large place of power flux density, and a small place. If the large part of power flux density is located in the core section A at this time, heat will occur by magnetic losses, such as eddy current loss. Formal covering used for the insulation between the coils 55 which constitute an inductor 53 by this may deteriorate with heat.
[0007] In order to avoid deterioration of such formal covering, he forms the air core section B in a part of inductor 53, and is trying for the large part of power flux density to come to the location of the air core section B.

[0008]
[Problem(s) to be Solved by the Invention] Here, drawing 8 explains the relation of the permeability and frequency about some ingredients of the ferrite core used for an inductor 53. Axes of abscissa are [a frequency (MHz) and the axis of ordinate of drawing 8] permeability. If a frequency becomes high and is set to about 100MHz as curvilinear a-d shows, permeability will fall [each ingredient]. Thus, a fall of the permeability of a ferrite core decreases the inductance L of the inductor 53 which constitutes a filter.
[0009] By the way, cut-off-frequency f of the L form filter of a low-pass frequency passage form is [Equation 1].

$$f = \frac{1}{2\pi\sqrt{LC}}$$

It is come out and shown. (1) By the formula, L is the inductance [H] of an inductor 53 and C is the capacitance [F] of a capacitor 52.
[0010] Therefore, if the inductance L of an inductor 53 decreases, cut-off-frequency f will become large. For example, in the case of the conventional filter, 1.2 microhenries and the capacitance C of a capacitor 52 of the inductance L of an inductor 53 are 500PF, and the cut off frequency has become 7MHz. With the filter of such a configuration, it is to about several 10MHz that there is effectiveness of noise control. However, there is advice of CISPR (Comite International Special des Perturbations Radioelectrique) etc., and the control to the radiated noise of a several 100MHz band is becoming important.
[0011] This invention solves the above-mentioned fault and aims at offering the magnetron for microwave ovens which controls the noise of a 500 to 1000MHz high frequency band especially.
[0012]
[Means for Solving the Problem] This invention is characterized by lessening 4 ******s from 2 from the number of turns when forming a coil by the die length equivalent to the half-wave length of the frequency of the noise which controls the number of turns of the coil coiled around the input terminal with which supply voltage is supplied at the periphery of the core part of said core form inductor in the magnetron for microwave ovens to which the filter which has a core form inductor is connected.
[0013] Moreover, it is characterized by to lessen 6 ******s from 4 from the number of turns when forming a coil by the die length equivalent to the half-wave length of the frequency of the noise which controls the number of each coil with which the filter which has the core form inductor by which the coil is divided and coiled around the common core is divided and wound around the periphery of the core part of said core form inductor in the magnetron connected to the input terminal with which supply voltage is supplied of turns.
[0014]
[Function] Since the filter of a configuration of that the Prior art explained also has effectiveness in noise control of a 500 to about 1000MHz specific high frequency band, when it analyzes this, it is as follows.
[0015] Here, the damping property of a filter is explained. In addition, a measuring circuit like drawing 9 is used for measurement of the damping property of a filter. 91 is a sweep oscillator and adds the scanning signal generated from the sweep oscillator 91 to a filter 92. And it is the approach of measuring the output of a filter 92 with a frequency analyzer 93.
[0016] The above-mentioned measuring circuit explains the example of the filter which measured the damping property with reference to drawing 10 and drawing 11 . Drawing 1010 shows the structure of the measured filter box, and drawing 11 shows the configuration of the inductor which constitutes a filter.
[0017] In drawing 10 , 101a and 101b are [an input terminal and 102] capacitors. 103 is an inductor, coils a coil 105 around a ferrite core 104, and is constituted. And a capacitor 102 and an inductor 103 constitute a filter and an inductor 103 is connected to the cathode of the magnetron body 105.
[0018] Moreover, as drawing 11 shows, an inductor is formed in the interior of a coil 105 from the core section A with a ferrite core 104, and the air core section B without a ferrite core 104.

[0019] In addition, when the wire size of D and a coil is set to d and coil spacing is set [the die length of coil 105b currently formed in La and the air core section B in the die length of coil 105a currently formed in the core section A] to g for Lb and the coil outer diameter of each coils 105a and 105b, it is La=14.8mm and Lb=12.7mm and they are D= 7.6mm, d= 1.4mm, and g= 0.08mm.
[0020] Moreover, a ferrite core 104 is moved in the direction of arrow-head Y of drawing 11 , and the ferrite core 104 is changing into 11.4mm, 9.6mm, and 8.3mm die-length H of the part (Ao) inserted in coil 105a, respectively. In addition, the die length Lc of a ferrite core 104 is 18mm, and a core diameter Dc is 4.5mm.
[0021] The damping property of the filter of a configuration of having described above is shown in drawing 12 R> 2 thru/or drawing 14 . Each drawing is [an axis of abscissa] a frequency (MHz), and, for a center, 520MHz and 1 graduation are [100MHz and an axis of ordinate] the magnitude of attenuation. The case where the cases where the cases where die-length H of the part (Ao) by which the ferrite core 104 is inserted in coil 105a is 11.4mm are drawing 12 and 9.6mm are drawing 13 and 8.3mm is drawing 14 .
[0022] About the frequency fc from which the expansion length l when extending to one coil 105a of the part (Ao) in which the number T of turns and ferrite core 104 of coil 105a of the part (Ao) in which the frequency fo with a damping effect and the ferrite core 103 are inserted are inserted for a long time based on this measurement result, and this expansion length l turn into the half-wave length, if each relation is made into a table, it will become as it is shown in Table 1.
[0023]
[Table 1]

H [mm]	f o [MHz]	T [ターン]	l [mm]	f c [MHz]
11. 4	740	7. 70	150. 5	997
9. 6	780	6. 49	126. 7	1184
8. 3	850	5. 61	109. 5	1369

・T＝H／P (巻線ピッチP＝巻線型d＋巻線間間隔g)
・$l = H \cdot \sqrt{((D-d) \cdot \pi / P)^2 + 1}$
・$fc = c/(2 \cdot l)$ (光速度$c = 2.997925 \times 10^8$ [m／s])

and the frequency fo (MHz) with a damping effect -- an axis of abscissa -- moreover, if the frequency fc (MHz) which makes the expansion length l of a coil the half-wave length is taken along an axis of ordinate, it will become like drawing 15 . Thus, correlation is looked at by a frequency fo and the frequency fc. In this case, a gap of fo and fc is considered for a part of field generated in coil 105b of the air core section B joining a ferrite core 104.
[0024] Moreover, the half-wave length of the frequency fo with a damping effect is made into l', and when the metal wire of the die length equivalent to this half-wave length l' is coiled so that the coil outer diameter D may be set to 7.6mm, die-length H' of the coil of ferrite core 104 direction and turn several T' become as it is shown in Table 2.
[0025]
[Table 2]

H [㎜]	fo [MHz]	l' [㎜]	H' [㎜]	T' [ターン]
11.4	740	202.6	15.35	10.37
9.6	780	192.2	14.56	9.84
8.3	850	176.3	13.36	9.03

・$l' = c/(2 \cdot fo)$ (光速度$c = 2.997925 \times 10^8$ [m/s])

・$H' = l' / \sqrt{((D-d) \cdot \pi / P)^2 + 1}$

(巻線外径D，巻線線径d)

(巻線ピッチP＝巻線線径d＋巻線間間隔g)

・$T' = H' / P$

Here, when turn several T' of the coil constituted from a metal wire of the die length equivalent to the half-wave length of the number T of turns of the coil of the part (Ao) by which the ferrite core 104 is inserted in coil 105a, and the frequency fo with a damping effect is compared, it turns out that T has 3.42 ******s of depressor effect with the small number of turns from 2.67 from T'.
[0026] The field which generates a coil according to the flowing noise current is consumed as magnetic loss inside a ferrite core, and the above-mentioned result is considered to be because for the noise spread to the exterior of a magnetron to have decreased.
[0027] In addition, if the expansion length of the coil 162 coiled around a ferrite core 161 becomes longer than half-wave length lambda / 2 of the frequency of a noise to control as drawing 16 shows, the magnetic flux 163 of the sense which negates the magnetic flux of the core 161 interior will occur, and magnetic loss will decrease. Moreover, when there is no air core section in the coil which constitutes an inductor and it is the half-wave length of the frequency of the noise which the expansion length of the coil coiled around a ferrite core wants to control, the amount of magnetic flux generated inside a ferrite core becomes max.
[0028] In addition, a part of the 2450MHz microwave power outputted from a magnetron gets across to an input side at a leakage inductor. At this time, the air core section B is usually formed in a magnetron body side so that microwave power may not be absorbed by the ferrite core. In this case, a part of magnetic flux generated with the coil of the air core section B goes into the interior of a ferrite core. For this reason, the number of turns of the coil (Ao) of the core section wound around a ferrite core has 4 ******s of damping effects in few condition from 2 from the number of turns at the time of constituting a coil from a metal wire of the die length equivalent to the half-wave length of the frequency of a noise to control.
[0029] Moreover, if the frequency of a noise to control constitutes a coil from a metal wire of the die length equivalent to the half-wave length of the frequency which it is going to control in the case of 500 to 1000MHz, die-length H of the coil of the direction of a ferrite core may be insufficient for the inductance which controls the noise of a 100MHz band. In this case, the inductor of structure which divided into plurality and coiled the coil is used. At this time, as for a ferrite core, a common thing is used to each coil so that an inductor may be settled in a filter box at a compact.
[0030] Here, the inductor of structure which divided into plurality and coiled the coil is explained. Below, taking the case of an inductor with the largest damping effect, drawing 17 explains with a 900MHz [700MHz to] band.
[0031] The core section to which a ferrite core 171 is located in the interior of a coil is the core section A1. Core section A2 They are two steps. and the core section A1 **** -- coil 172a -- the core section A2 **** -- coil 172b is formed. the die length of coil 172a -- the die length of L1 and coil 172b -- spacing of L2, coil 172a, and coil 172b -- the die length of the coil 173 of G and the air core section B -- L3 and a coil outer diameter -- the wire size of D and a coil -- d -- and When coil spacing is set to g, they are L1=7.35mm, L2=7.35mm, G= 3.0mm L 3= 10.2mm, D= 7.6mm, d= 1.4mm, and g= 0.08mm. Moreover, die-length Lc of a ferrite core 171 and a core diameter Dc are Lc=20mm and Dc=4.5mm,

respectively. Moreover, the spacing Gc of a core edge and coil 172a is Gc=3.0mm.
[0032] Moreover, the die length H1 of the part (Ao1) by which the ferrite core 171 is inserted in coil 172a The die length H2 of the part (Ao2) by which 7.35mm (H1 =L1) and a ferrite core 171 are inserted in coil 172b It is 6.65mm (H2 =Lc-Gc-L1-G).
[0033] The damping property measured about the filter of a configuration of having described above in the measuring circuit of drawing 9 which explained previously is shown in drawing 18 . An axis of abscissa is a frequency (MHz) and, for a center, 520MHz and 1 graduation are [100MHz and the axis of ordinate of drawing 18] the magnitude of attenuation.
[0034] several turns of the coil of a part (Ao1) (Ao2) with which the frequency fo with a damping effect and the ferrite core 171 are inserted in Coils 172a and 172b here -- if the relation of the frequency fc which makes T, the expansion length l of a coil, and this expansion length l the half-wave length is shown, it will become as it is shown in Table 3.
[0035]
[Table 3]

	fo [MHz]	T [ターン]	l [mm]	fc [MHz]
(コア部A_{01}) H_1 =7.35mm	800	4.97	97.0	1545
(コア部A_{02}) H_2 =6.65mm	800	4.49	87.8	1707

・T＝H／P　（巻線ピッチP＝巻線線径d＋巻線間間隔g）

・$l = H \cdot \sqrt{((D-d) \cdot \pi / P)^2 + 1}$　（巻線外径D）

・fc＝c／（2・l）（光速度c＝2.997925×10^8 [m／s]）

Moreover, if coil die length rolled so that a coil outer diameter might be set to 7.6mm is made into H' using the metal wire of the die length equivalent to half-wave length l' of the frequency fo with a damping effect and the number of turns is made into T', those relation will become as it is shown in Table 4.
[0036]
[Table 4]

fo [MHz]	l' [mm]	H' [mm]	T' [ターン]
800	187.4	14.2	9.59

・l'＝c／（2・fo）（光速度c＝2.997925×10^8 [m／s]）

・$H' = l' / \sqrt{((D-d) \cdot \pi / P)^2 + 1}$

（巻線外径D，巻線線径d）

（巻線ピッチP＝巻線線径d＋巻線間間隔g）

・T'＝H'／P

several turns of the coil of a part (Ao1) (Ao2) with which the ferrite core 171 is inserted in each coils 172a and 172b -- if turn several T' of the coil constituted from a metal wire of the die length equivalent to the half-wave length of T and the frequency fo with a damping effect is compared, T is few 5.10 ******s from 4.62 from T'.
[0037] It is effective with the number of turns smaller than the case where it concentrates on one field and there is a coil since leakage flux is in each coil when it divides and constitutes a coil to two or more fields of a common ferrite core as described above, and effectiveness produces the number of turns of the coil of each inductance from 4 6 ******s in few places from the case where it constitutes from a metal wire of the die length equivalent to the half-wave length of the frequency which wants to control a

noise.
[0038]
[Example] Hereafter, one example of this invention is explained with reference to drawing 1 . Drawing 1 is drawing showing the input part of the magnetron for microwave ovens, and 11a and 11b are input terminals, and are connected to a power source (not shown). The capacitor 12 and the inductor 13 are connected to input terminals 11a and 11b. In addition, the core form inductor by which the inductor 13 coiled the coil 15 around the periphery of a ferrite core 14 is used. And an inductor 13 is connected to the cathode (not shown) of the magnetron body 16. In addition, a capacitor 12 and an inductor 13 form a low-pass frequency passage form filter, and control the noise which leaks outside through input terminals 11a and 11b.
[0039] Moreover, an inductor 13 is a wave absorber and consists of core form inductors which coiled the coil 15 around the periphery of the high ferrite core 14 of relative permeability as shown in drawing 2 . In addition, a coil 15 consists of coil 15a of the core section A which has a ferrite core 14 in the interior, and coil 15b of the air core section B without a ferrite core 14, and coil 15b of the air core section B is connected to the cathode of the magnetron body 16.
[0040] With the above-mentioned configuration, the number of turns of the coil length H part of coil 15a of the core section A is lessened 4 ******s from 2 from the number of turns in the case of constituting a coil from a metal wire of the die length equivalent to the half-wave length of the frequency of the noise which it is going to control.
[0041] Next, other examples of this invention are explained with reference to drawing 3 . Drawing 3 is drawing showing the input part of the magnetron for microwave ovens, and 31a and 31b are input terminals, and are connected to a power source (not shown). The capacitor 32 and the inductor 33 are connected to input terminals 31a and 31b. In addition, the core form inductor by which the inductor 33 coiled the coil 35 around the periphery of a ferrite core 34 is used. And an inductor 33 is connected to the cathode (not shown) of the magnetron body 36. In addition, a capacitor 32 and an inductor 33 form a low-pass frequency passage form filter, and control the noise which leaks outside through input terminals 31a and 31b.
[0042] In addition, the core section of the inductor to which a ferrite core is located in the interior of a coil is the core section A1, as shown in drawing 4 . Core section A2 It is divided into two steps. the core section A1 **** -- coil 35a -- moreover, the core section A2 **** -- coil 35b is rolled. And a coil 36 is coiled around the air core section B which does not have a ferrite core 34 in the interior, and the coil 36 is connected to the magnetron body.
[0043] It sets in the above-mentioned configuration and is the core section A1. Coil length H1 of coil 35a The number of turns and the core section A2 of a part Coil length H2 of coil 35b The number of turns of a part is lessened 6 ******s from 4 from the number of turns at the time of constituting a coil using the metal wire of the die length equivalent to the half-wave length of the frequency of a noise to control.
[0044]
[Effect of the Invention] According to this invention, the noise of a 500 to 1000MHz frequency band can be controlled especially.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing explaining one example of this invention.
[Drawing 2] It is drawing explaining one example of this invention.
[Drawing 3] It is drawing explaining other examples of this invention.
[Drawing 4] It is drawing explaining other examples of this invention.
[Drawing 5] It is drawing explaining the conventional example.
[Drawing 6] It is drawing explaining the conventional example.
[Drawing 7] It is drawing explaining the conventional example.
[Drawing 8] It is drawing explaining the property of a ferrite core.
[Drawing 9] It is drawing showing the measuring circuit of a damping property.
[Drawing 10] It is drawing explaining other conventional examples.
[Drawing 11] It is drawing explaining other conventional examples.
[Drawing 12] It is drawing explaining the damping property of a filter.
[Drawing 13] It is drawing explaining the damping property of a filter.
[Drawing 14] It is drawing explaining the damping property of a filter.
[Drawing 15] It is drawing explaining the property of a filter.
[Drawing 16] It is drawing explaining the property of an inductor.
[Drawing 17] It is drawing explaining the conventional inductor.
[Drawing 18] It is drawing explaining the damping property of a filter.
[Description of Notations]
11a, 11b -- Input terminal
12 -- Capacitor
13 -- Inductor
14 -- Ferrite core
15 -- Coil
16 -- Magnetron body

[Translation done.]

* NOTICES *

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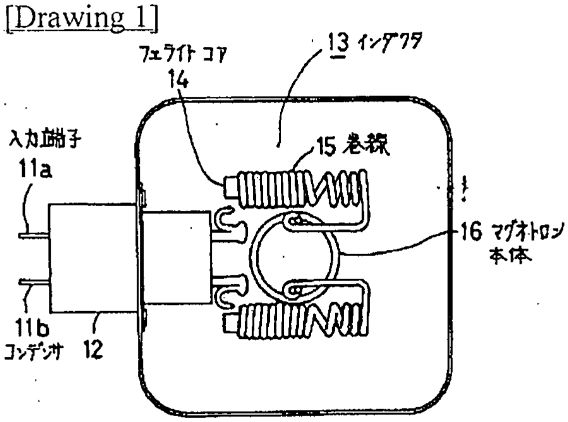
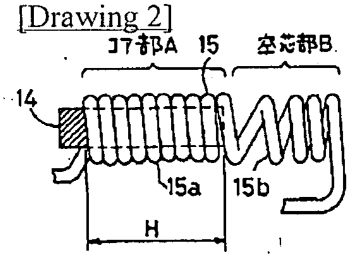
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

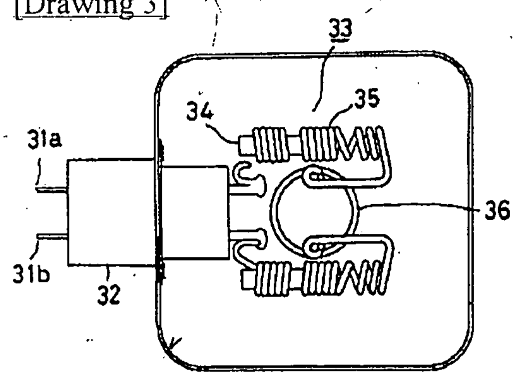
[Drawing 1]



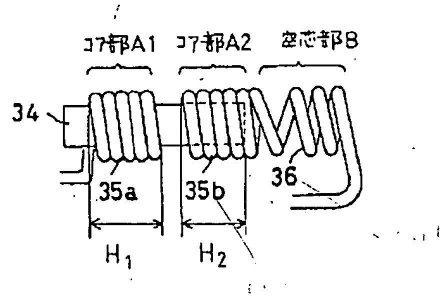
[Drawing 2]



[Drawing 3]



[Drawing 4]



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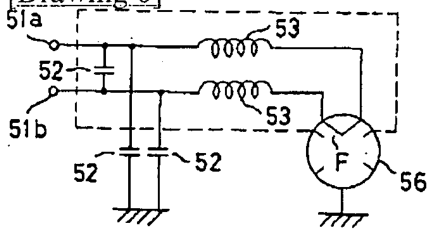
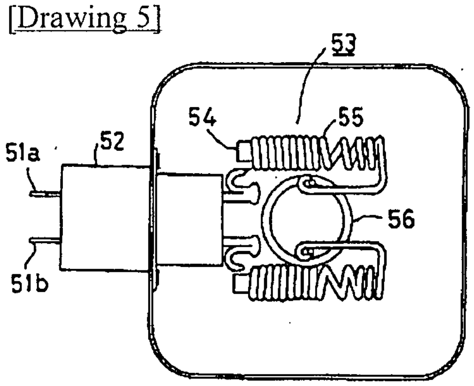
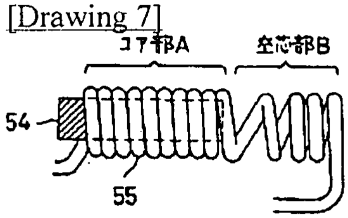


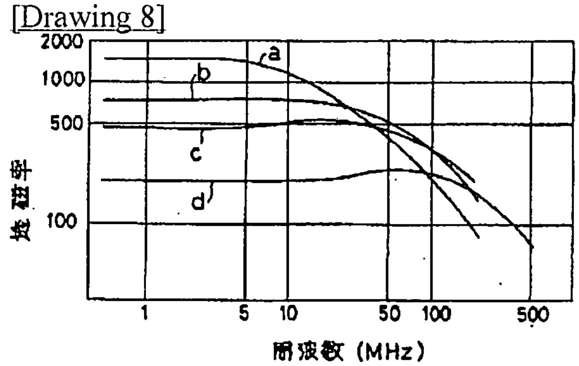
[Drawing 5]



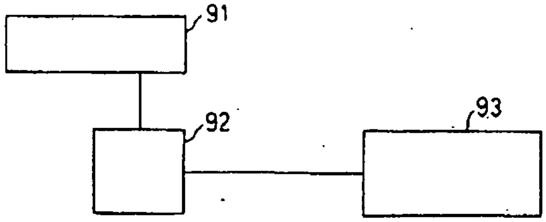
[Drawing 7]



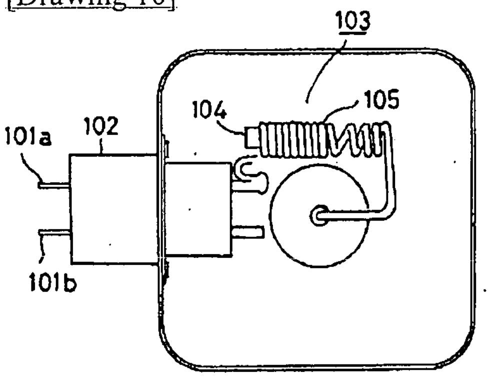
[Drawing 8]



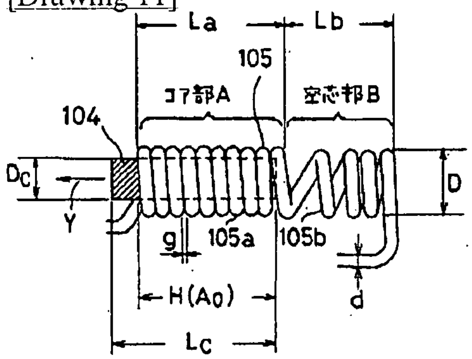
[Drawing 9]



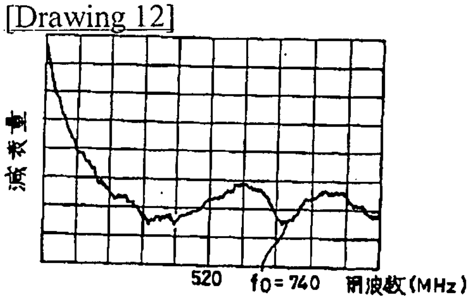
[Drawing 10]



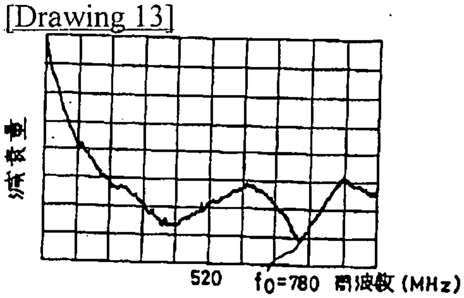
[Drawing 11]



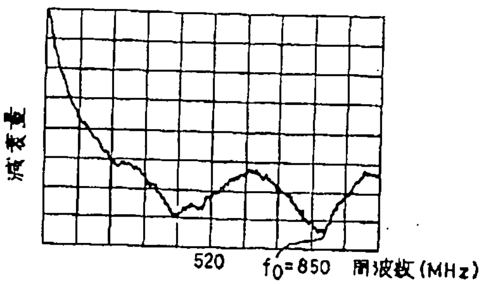
[Drawing 12]



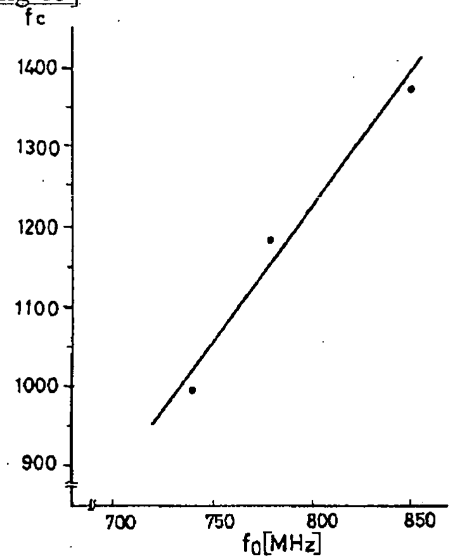
[Drawing 13]



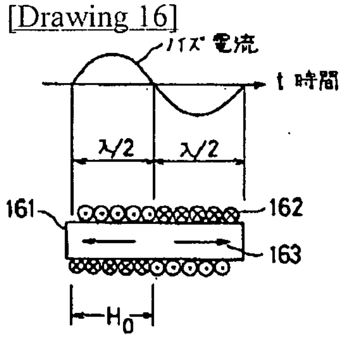
[Drawing 14]



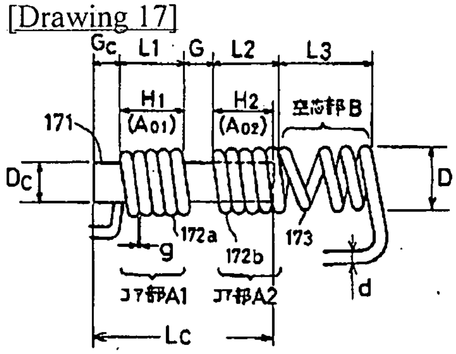
[Drawing 15]



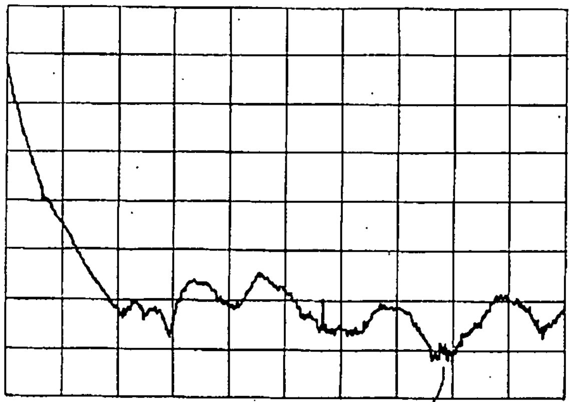
[Drawing 16]



[Drawing 17]



[Drawing 18]



[Translation done.]